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EXHIBITS


Flood Profiles

Wood River — Panel 01P

Flood Boundary and Floodway Map


PUBLISHED SEPARATELY:

Flood Insurance Rate Map



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FLOOD INSURANCE STUDY

CITY OF WOOD RIVER,
HALL COUNTY,
NEBRASKA

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

The purpose of this Type 19 Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Wood River, Hall County, Nebraska, and to aid in the administration of the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to revise the Flood Insurance Rate Map developed from data presented in the Type 15 Flood Insurance Study. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

### 1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Kirkham, Michael and Associates (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-83-C-1192. This study was completed in December 1984.

### 1.3 Coordination

Community base map selection and the identification of streams requiring detailed restudy were made in meetings held during April 1983 attended by personnel of FEMA and the Study Contractor. Hydrologic analyses and flood profiles for the Wood River were coordinated by the Study Contractor with those previously performed by the same Study Contractor in 1977 (Reference 1).

During the course of the work, flood elevations, flood boundaries, and floodway delineations were reviewed with community officials and with officials of the Nebraska Department of Natural Resources Commission, U.S. Army Corps of Engineers (COE), U.S. Geological Survey (USGS), U.S. Department of Agriculture, Soil Conservation Service (SCS), U.S. Department of the Interior, Bureau of Reclamation, and the Central Platte Natural Resources District.



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In August 1985, the results of this Flood Insurance Study were reviewed and accepted by representatives of the community.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the incorporated area and its 1 mile of extraterritorial limits of the City of Wood River, Hall County, Nebraska. The area of study is shown on the Vicinity Map (Figure 1).

Flooding caused by overflow of the Wood River within the extraterritorial limits of the City of Wood River was studied in detail.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

The areas studied were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through December 1989. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Wood River.

### 2.2 Community Description

The City of Wood River is located in south-central Hall County, in central Nebraska, approximately 20 miles southwest of the City of Grand Island. The Village of Shelton is 7 miles upstream of the City of Wood River and the Village of Alda is 8 miles downstream of the City of Wood River on the Wood River. The City of Wood River is completely surrounded by the unincorporated areas of Hall County. The population of the City of Wood River was reported to be 1,334 in 1980, an increase of 187 over the 1970 population (Reference 2). The economy of the area is primarily agriculture.

Short grasses predominate in uncultivated areas. Willow and cottonwood trees grow along the Wood River. The Wood River flows through the northern portion of the City of Wood River and has very little development along its course, with the exception of the new sewage treatment plant and Wood River Elementary School. The surrounding landscape is predominately flat to gently rolling loess hills, while the upland area in the basin above the Wood River is gently rolling to steep. The soils in the Wood River basin are predominately silt loam or fine sandy loam of the Hobbs, Holdrege, Hard, Colby, Uly, Hall, and Gibbon series (Reference 3).

Most of the precipitation in Wood River falls during showers and thunderstorms occurring in the months of April to September. The annual rainfall is 24 inches (Reference 3).

Development within the Wood River flood plain is primarily agricultural with some residential development.



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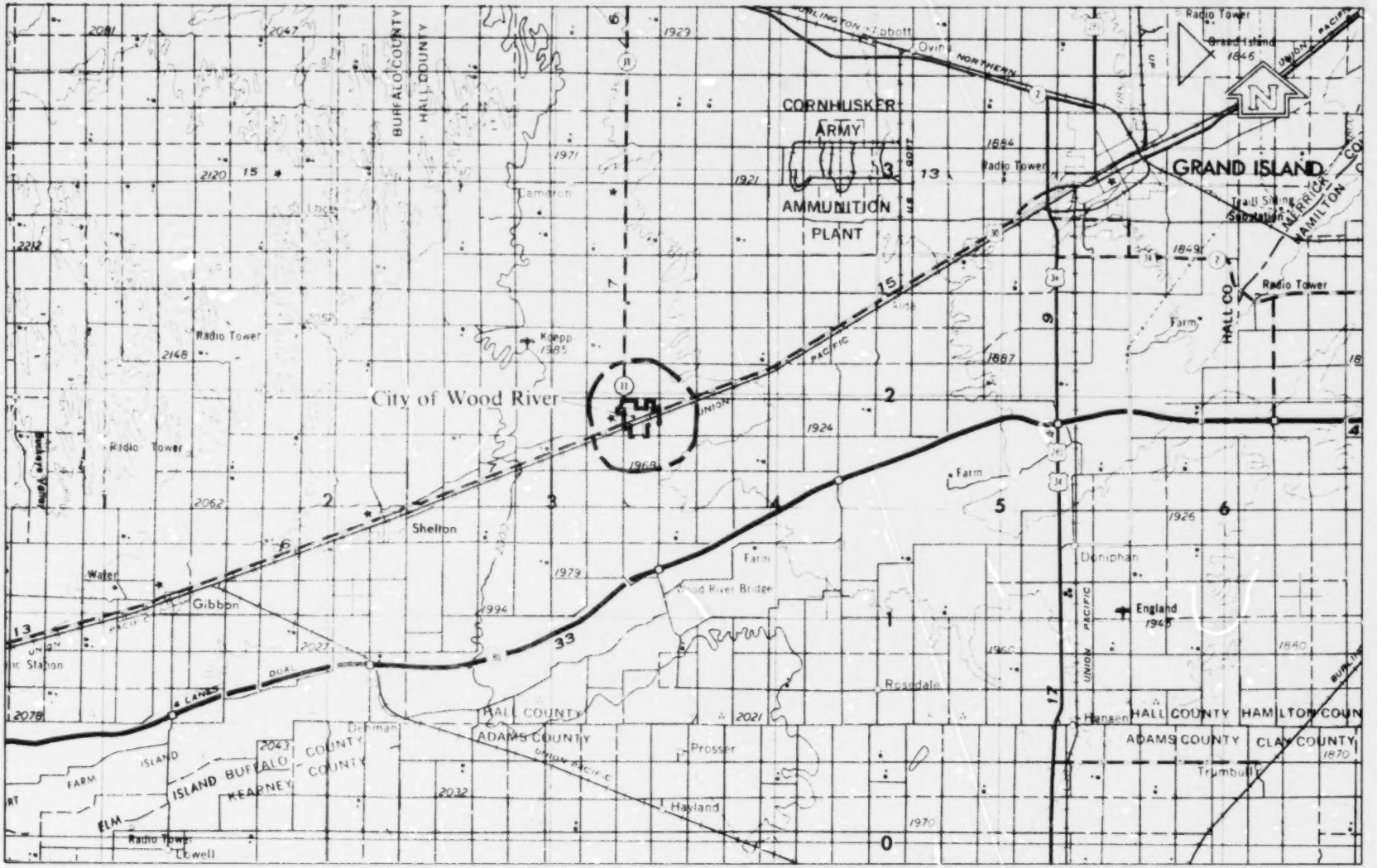


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

# CITY OF WOOD RIVER, NE

(HALL CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

## VICINITY MAP

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## 2.3 Principal Flood Problems

The banks of the Wood River are actually higher than the surrounding flood plains. A low-lying drainage area to the south of the Wood River and to the north of U.S. Highway 30 causes flooding through the business area of the City of Wood River along U.S. Highway 30. This is aggravated by overflows out of the Wood River during the 500-year flood. This water cannot reenter the main channel of the Wood River until it joins approximately 1 mile northeast of the community.

## 2.4 Flood Protection Measures

In 1968, the Nebraska State Department of Roads constructed a ditch between U.S. Highway 30 and the Union Pacific Railroad to help alleviate the drainage problem from the drainage area to the west. Presently, no major flood protection structures are in operation on the Wood River.

# 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

## 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

The revised frequency-discharge information for the Wood River was computed using gage data recorded by the USGS at the Alda gage on the Wood River, downstream of the City of Wood River. Also, as a check, a USGS gage near the City of Gibbon, Nebraska, upstream of the City of Wood River, was analyzed.

Peak discharges for the 1949 through 1976 water years were used in analyzing the Gibbon, Nebraska, gage data.

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Peak discharges for the 1954 through 1983 water years were used in the Alda, Nebraska gage analysis. A low value of 15 cubic feet per second (cfs) for the year 1981 was deleted from the remainder of the Alda data.

Frequency-discharge curves were developed for the above gages using the log-Pearson Type III analysis (Reference 4).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (SQ MILES) | PEAK DISCHARGE (CFS) 10-YEAR | 50-YEAR | 100-YEAR | 500-YEAR |
|---|---|---|---|---|---|
| WOOD RIVER | | | | | |
| at USGS gage at Gibbon | 572 | 2,000 | 3,750 | 4,550 | 6,550 |
| at confluence with the North Channel Platte River | 628 | 1,030 | 1,660 | 1,930 | 2,550 |

As indicated in Table 1, the peak discharges at the Gibbon gage (located upstream of the City of Wood River) are substantially higher than the peak discharges for the Alda gage (located downstream of the City of Wood River). Field reconnaissance and study indicates flows permanently leave the Wood River channel area in a southerly direction between Shelton and Gibbon, Nebraska. It is also believed that due to the long and narrow configuration of the drainage basin, as well as soil type and topography, the characteristics of the peak storm runoff are influenced to the extent that the lower reaches of the Wood River reflect substantially lower peak discharges in relation to the total runoff volume. Flows shown in Table 1 are substantially lower than flows previously presented in earlier study work (Reference 1).

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross-section data were obtained by field measurement. All bridges and culverts were surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map.

Roughness coefficients (Manning's "n") used in the hydraulic computations for the detailed study streams were estimated by field inspection. They ranged from 0.040 in the channel section to 0.060 in the overbank areas. Water-surface profiles were developed using a HEC-2 step-backwater computer model (Reference 5).

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Starting water-surface elevations were determied from a detailed back-water analysis through downstream reaches of the Wood River.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals. In cases where the 50- and 100-year flood elevations are close together, due to limitations of the profile scale, only the 100-year profile has been drawn.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are, thus, considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

### 4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24000 with a contour interval of 5 feet (Reference 6).

For the streams studied by approximate methods, only the 100-year flood plain boundary was delineated using the Type 15 Flood Insurance Study for the City of Wood River (Reference 1).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map. In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

### 4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist



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local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 2, Floodway Data.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and the 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway of the Wood River lie outside the extraterritorial limits.

The area between the floodway and the 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

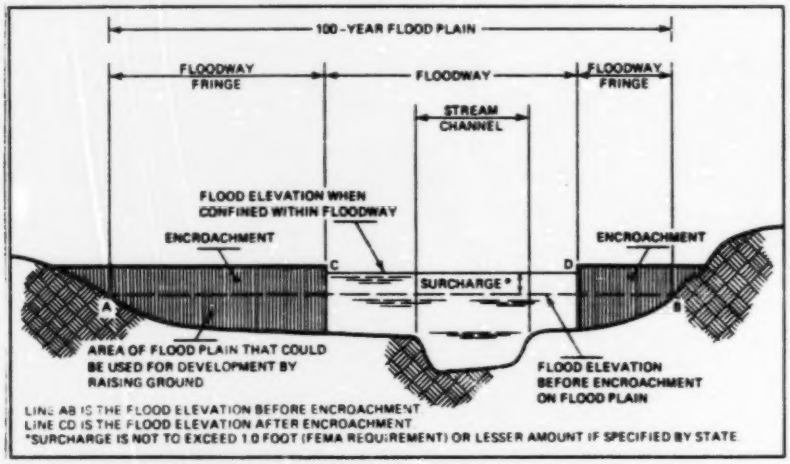
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.



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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| WOOD RIVER | | | | | | | | |
| A | 94,300 | 197[2] | 953 | 2.0 | 1955.5 | 1955.5 | 1956.5 | 1.0 |
| B | 96,400 | 313 | 1533 | 1.2 | 1956.2 | 1956.2 | 1956.9 | 0.7 |
| C | 97,900 | 249 | 836 | 2.3 | 1956.7 | 1956.7 | 1957.3 | 0.6 |
| D | 98,060 | 386 | 998 | 1.9 | 1957.8 | 1957.8 | 1958.1 | 0.3 |
| E | 100,060 | 137 | 653 | 3.0 | 1959.6 | 1959.6 | 1959.6 | 0.0 |
| F | 102,185 | 268 | 833 | 2.3 | 1961.4 | 1961.4 | 1961.4 | 0.0 |
| G | 103,685 | 173 | 895 | 2.2 | 1962.3 | 1962.3 | 1962.3 | 0.0 |
| H | 106,060 | 226 | 1110 | 1.7 | 1963.1 | 1963.1 | 1963.1 | 0.0 |
| I | 107,310 | 221 | 746 | 2.6 | 1963.6 | 1963.6 | 1963.6 | 0.0 |
| J | 107,840 | 112 | 505 | 3.8 | 1965.3 | 1965.3 | 1965.3 | 0.0 |
| K | 109,340 | 378 | 1259 | 1.5 | 1966.5 | 1966.5 | 1966.5 | 0.0 |
| L | 109,620 | 372 | 1007 | 1.9 | 1966.8 | 1966.8 | 1966.8 | 0.0 |
| M | 113,920 | 345 | 997 | 1.9 | 1969.7 | 1969.7 | 1969.7 | 0.0 |
| N | 118,420 | 270 | 920 | 2.1 | 1972.6 | 1972.6 | 1972.6 | 0.0 |

[1]FEET ABOVE U.S. HIGHWAY 281
[2]THIS WIDTH IS BEYOND EXTRATERRITORIAL LIMITS

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TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF WOOD RIVER, NE**

**(HALL CO.)**

**FLOODWAY DATA**

**WOOD RIVER**

## 5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Wood River.

### 5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the weighted average difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the riverine flooding sources of the City of Wood River are shown on the Flood Profiles and are summarized in Table 3, Flood Insurance Zone Data.

### 5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a riverine reach is the weighted average difference between the 10- and 100-year flood water-surface elevations rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code. For example, if the difference between elevations is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference is greater than 10.0 feet, it is rounded to the nearest whole foot.

### 5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.



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| | |
|---|---|
| Zone A4: | Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and, areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding; not subdivided. |

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are shown in Table 3, Flood Insurance Zone Data.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Wood River is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines for riverine flooding sources show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

## 6.0 OTHER STUDIES

A Type 15 Flood Insurance Study was prepared for the City of Wood River (Reference 1). More detailed study in this Type 19 report has since indicated that discharges used in the Type 15 study were higher than those that can actually be expected for a given recurrence interval. A Type 19 Flood Insurance Study is in progress for the Unincorporated Areas of Hall County, (Reference 7) and is in agreement with this report.

## 7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Old Federal Office Building, Room 300, 911 Walnut Street, Kansas City, Missouri 64106.

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| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION[3] (FEET NGVD) |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| WOOD RIVER | | | | | | | |
| REACH 1 | 0005 | −1.8 | −0.4 | 1.0 | 020 | A4 | VARIES—SEE MAP |

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

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TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF WOOD RIVER, NE**

**(HALL CO.)**

**FLOOD INSURANCE ZONE DATA**

**WOOD RIVER**

## 8.0 REFERENCES AND BIBLIOGRAPHY


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6. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Interval 5 Feet: Wood River, Nebraska, 1962.

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